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MERMAIDS UNCOVERED

PAOLO VISCARDI, ANITA HOLLINSHEAD, ROSS MACFARLANE, and JAMES MOFFATT

Introduction

Many museums and private collections in the UK, Europe, and the USA hold cultural artefacts of the type commonly referred to as mermen or 'feejee mermaids'. Most of these are accompanied by little in the way of information about their origins, but they are generally associated with Asia and particularly with Japan. Perhaps as a result of their poor provenance, it is unusual for such specimens to be interpreted with reference to stories from their culture of origin; they are thus usually discussed on the basis of their authenticity—or lack thereof. Indeed, they are commonly regarded as hoaxes constructed from monkeys attached to fish, largely on the basis of supposition influenced by historical narratives (see Overmeer Fisscher 1833, Timbs 1867). The most infamous example of such a specimen is the eponymous Feejee Mermaid, exhibited by master showman P. T. Barnum from 1842 until it was probably destroyed in a museum fire between 1865 and 1880 (see Bondeson 1999: 56).

The notoriety of Barnum's Feejee Mermaid was a product of clever and deliberate obfuscation and manipulation of the facts (see Cook 2001), which has served to create an aura of mystery and confusion around feejee mermaids in general. Lack of honest depictions of, and information about, the Feejee Mermaid has allowed speculation that some mermaid figures, such as the specimen at the Peabody Museum (see Levi 1977), or the example discovered in a domestic attic in Southend (see Anonymous 1988) may be Barnum's famous specimen. Such claims are ill-founded (see Nickell 2005) and blur distinctions between different specimens. With such a background of inveterate misinformation, it is little wonder that museums interpret and care for their feejee mermaids on the unchallenged understanding that they are taxidermy chimeras.

With the advent of new technologies, such as computed tomography (CT) and phosphor plate X-radiography, such received wisdom can be put to the test by undertaking detailed non-invasive analysis of specimens. Minimally destructive methods such as sampling of DNA, protein, and hair may also be used to establish what materials have been used in the construction of specimens.

Of course, such methods require expertise, necessitating interdisciplinary collaboration and communication. Such collaboration can inform and inspire more varied and exciting interpretations of objects when they are displayed.

In this article we report some of the outcomes from such an approach applied to mermaid specimens held by the Horniman Museum & Gardens and Buxton Museum and Art Gallery. The work was stimulated by the 'Object in Focus' loans project run by the Horniman and funded by Arts Council England (formerly MLA). 'Objects in Focus' improved access to underutilized objects in the Horniman collection by loaning them to other organizations, along with a display-case and interpretation developed in collaboration with external partners.[1]

Archival Research

Both the Buxton and Horniman specimens were identified as having been transferred from the Wellcome Historical Medical Museum, prompting MacFarlane to search in the Wellcome archives for any information about the mermaids that had been acquired by Sir Henry Wellcome and their subsequent dispersal. Over the course of his lifetime, Wellcome amassed more than a million objects (Skinner 1986). Due to the scale of the collections it describes, the surviving documentation requires careful investigation, in order to tease out details on an individual item's provenance.[2] This means that to trace the details of an object, one must know the Wellcome accession number.

How Wellcome's collection was amassed has been the focus of a number of detailed studies (see, for example, Skinner 1986, Larson 2009) that have revealed the interesting relationships that existed between Sir Henry, key members of his staff, and the auction houses from which large parts of his collection were purchased. Of particular note here is Stevens Auction Rooms of Covent Garden, London, who pioneered the selling of 'ethnological' items, including the mummy of Queen Nefertari, other mummies from around the world, *tsantsas*, and—indeed—mermaids. Among the large and complex body of documentary materials relating to Wellcome's collection are auction catalogues from the period in which Wellcome was collecting that allow the original listings for specimens to be traced.

The documentation relating to the acquisition of the mermaid now in Buxton indicated that it was one of a number of items that the Wellcome transferred to other museums in 1982. The Wellcome had originally given two mermaids to the Horniman, but correspondence held by Derbyshire Museums Service (DMS) shows that in 1988 the Horniman transferred one of these to Buxton Museum via the DMS schools loans service. In Buxton it was classified as part of the 'archaeology' collections, given the DMS number A331, and displayed undisturbed for the next twenty-two years.

The original Wellcome inventory card for the Buxton mermaid (Wellcome number A67128) reads: 'EMBALMED MERMAID In glass case (belonged to the Colonial Surgeon Mr Graham of Sierra Leone, Luc. Nat.) Case 21½" high 15" diameter Bought of: St 574/4/XII/1928 Value: £8 10 0'. The 'St' indicates that it was purchased at Stevens, allowing cross-referencing with the auction catalogue detailing the sale on 4 December 1928, where the specimen was listed as: 'An embalmed mermaid (belonged to the Colonial Surgeon, Mr Graham of Sierra Leone...); this was on exhibition some years ago and a considerable amount was collected to view for a hospital benefit' (Stevens 1928: 25).

The Horniman merman (Wellcome number A17758) had also been purchased at a Stevens auction, on 2 September 1919. The specimen was one of a number of lots titled: 'A Collection of Native Weapons, Carvings, etc.', with the sub-heading 'The Property of an Officer. Without Reserve' (Stevens 1919: 22). Lot 391 reads: 'Japan—Mermaid, papier-mache [*sic*] body, 20 inches by 9 inches'. A pencil annotation in the copy of the catalogue in the Wellcome Library records that the object had been purchased for £3. Unfortunately, no name is given for the officer, blocking further research into the provenance of the specimen.

The discovery of the history of the Horniman merman did, however, overlap with a piece of research carried out on another mermaid purchased by Wellcome and now on permanent loan to the Science Museum. Again, following its accession number through the Wellcome Archives to Stevens auction catalogues enabled its purchase to be traced to auctions of 'native curios' on the 27 and 28 January 1931, where it was listed as Lot 83: 'Japanese mermaid, 2 babies ditto and a fine specimen beaver, mounted on a wood stand' (Stevens 1931: 7); it was purchased for £2 10*s*.

Why did Henry Wellcome acquire at least three mermaids? His primary interest lay in the history of medicine, as evidenced by his Historical Medical Museum, opened in 1913. In 1928 Wellcome described to the Royal Commission on National Museums and Galleries how he wished to create a 'Museum of Man', ranging across time and global in conception, of which his Historical Medical Museum would form just a part (see Larson 2009: 155). In the words of the museum's curator, it 'connect the links in the chain of human experience…which stretch back from the present time into the most remote ages of the great past' (see Conservator 1926: 6).

This expression of his vision makes clear why one of the main collecting focuses for Wellcome was ethnographic material, which comprised more than half of his collection (see Arnold and Olsen 2003); and it may help explain why he acquired mermaids. Also, Wellcome's interest in mythology and folklore should be considered; after all, he did choose the unicorn, with its cure-all horn, as the symbol for his pharmaceutical business (see Church and Tansey 2007: 40, Fig. 1.18)

Figure 1. One of the earliest depictions of the specimen that was to become the Feejee Mermaid, an example of the 'Scream' type Japanese mermaid or ningyo*; from the copy of* A Description of the Mermaid *(Anonymous 1822) in the collections of the British Library (Asia, Pacific & Africa P|T 2937). Courtesy and copyright, The British Library Board.*

Mermaids in Context

Mythological water spirits have been depicted in the art of numerous cultures over millennia. Notable examples include the Mesopotamian sage Adapa, the Syrian sea-goddess Atargatis, the Greek sea-god Triton, the Inuit sea-goddess Taleelajuq, the African water-spirit Mami Wata, the Australian Aboriginal water-spirit Yawkyawk, and the European water spirit Melusine. The narratives associated with these gods, goddesses, and spirits vary considerably, of course, with some portrayed as beneficent, others as malevolent, and some as both (possibly reflecting perceptions of the sea as both bounteous provider and fickle destroyer). Depictions also vary considerably, but often converge on a form with a human torso and a fishtail. It is therefore unsurprising that interpretations of depictions of mermaids can be strongly influenced by the cultural bias of the observer at the expense of interpretations grounded in the culture of the creator. Yet, particular depictions may hold specific meanings,

or relate to particular narratives from the culture of origin, that were lost or superseded by new narratives when the objects were translocated. These lost meanings and narratives can provide insights into the culture of origin and are worth rediscovering and reassociating with the objects in question.

Japanese representations of mermaids in the late eighteenth and early nineteenth century typically stand on the curve of their tail, their hands in a pose reminiscent of the central figure of Edvard Munch's famous series of paintings *Der Schrei der Natur* (1893–1910) popularly known as *The Scream*. The Feegee Mermaid conformed to this type (see Figure 1). Surviving examples of the type are held by the British Museum and the National Museum of Ethnology, Leiden, where the Jan Cock Blomhoff specimen is held, one of the few surviving museum mermaid specimens mentioned in a contemporary account (see Overmeer Fisscher 1833). These types of mermaid or *ningyo* are also still to be found in Buddhist and Shinto shrines in Japan. Some are reputed to be of great antiquity, their acquisition being associated with moral stories—a tradition not restricted to *ningyo*, as manufactured representations of other supernatural creatures (*yōkai*) such as the popular *kappa* (see Foster 1998) are also represented.

Depictions of such *yōkai* were popularized in late eighteenth-century Japan by the artistic works of Japanese folklore scholar Toriyama Sekien (1712–1788). At the time, Japan was closed to foreigners as a result of the *sakoku* or 'locked country' policy of the Tokugawa administration, with only the Chinese and Dutch acknowledged as trading partners. So it was almost certainly at a popular Misemono carnival on the Dutch trading island of Dejima in the bay of Nagasaki that *ningyo* were first brought to the attention of Europeans. In the 1820s, P. F. von Siebold made reference to the story of a fisherman claiming to have caught a mermaid that, with its dying breath, predicted a time of great prosperity but also a fatal epidemic that could be averted by owning a likeness of the mermaid (see Busk 1841).[3] With this encouragement, examples of manufactured *ningyo* began to appear alongside a variety of attractions and goods at Misemono carnivals of the late eighteenth and early nineteenth centuries (see Markus 1985). Moreover, it might be expected that they would conform to a narrow set of depictions, since they were meant to be in the likeness of the original.

Somewhat different to what we might call the 'scream' type is the 'crawling' type that is commonly seen in collections, and of which the Horniman and Science Museum mermaids are good examples. Such specimens are supported on their arms with their tail lacking a strong curve. They have deeply sculptured details of ribs and vertebrae (often continuing far up the back of the head), the eyes are circular indentations, and some of these specimens have wispy white 'hair' on the head and beard area, and sometimes on the shoulders and arms. This type was first described in detail by Francis T. Buckland in 1858 (see Buckland 1860: 306–14) and further discussed by him in relation to their contemporary Japanese production in 1866 (see Buckland 1868: 143). These

dates are significant, since they postdate the Convention of Kanagawa and the Anglo-Japanese Friendship Treaty, both of 1854, which enabled wider trade with Japan. They also fall within the range of dates that the Feegee Mermaid was being exhibited in America and England. Since other museums were acquiring mermaids to compete with Barnum's attraction (see Cook 2001: 314), it seems plausible that the 'crawling type' may have been produced primarily for the museum market. Alternatively, given that the socio-political climate leading to the Meiji upheaval eroded many of the traditions of Edo-period Japan (see Groemer 1999), specimens in private Japanese hands may have been sold by their owners

Japanese Monkey-Fish

'Is the merman real?' and 'What is the merman made from?' are two of the questions that are most frequently asked of the Horniman's Collections Conservation and Care department. It was in an effort to answer these questions that Viscardi, a natural history curator with experience of identifying animals from teeth and bones, became involved with the 'Japanese Monkeyfish', as the merman is described in the Horniman's accession register (Figure 2). The specimen is part of the Horniman's natural history collections, perhaps in wry acknowledgement of its status as an unusual 'species', but more likely because it was considered to be a taxidermy creation and thus better off stored with objects of the same type.

Initial inspection revealed that the interpretation of the merman as a taxidermy monkey attached to a fish was incorrect. The specimen lacks the distinctive set of four incisors in top and bottom jaws found in simians; instead the jaws contain several rows of teeth (Figure 2b) and appear to be from a fish—most likely a type of wrasse.[4] Close examination of the torso of the specimen under a microscope revealed a matrix containing fibres, consistent with papier-mâché. The only part of the specimen to match expectations was the tail, which—given the structure of the scales—is most likely from a species of carp (Figure 2c). It was hoped that species-level identification of the fish would confirm the region of the world in which the specimen was made. Unfortunately, despite the best efforts of the laboratory of Professor Markus Pfenninger at the Goethe-Universität, Frankfurt, DNA retrieved from samples taken from the teeth and tail were too degraded to yield useful information—a common problem when testing DNA of older museum specimens. Without the independent information provided by species data, the provenance of the specimen could only be determined on the basis of archival information and data associated with similarly constructed examples.

The construction of the specimen was researched in greater detail through X-radiography (conducted on site using a mobile X-ray service) and CT scans

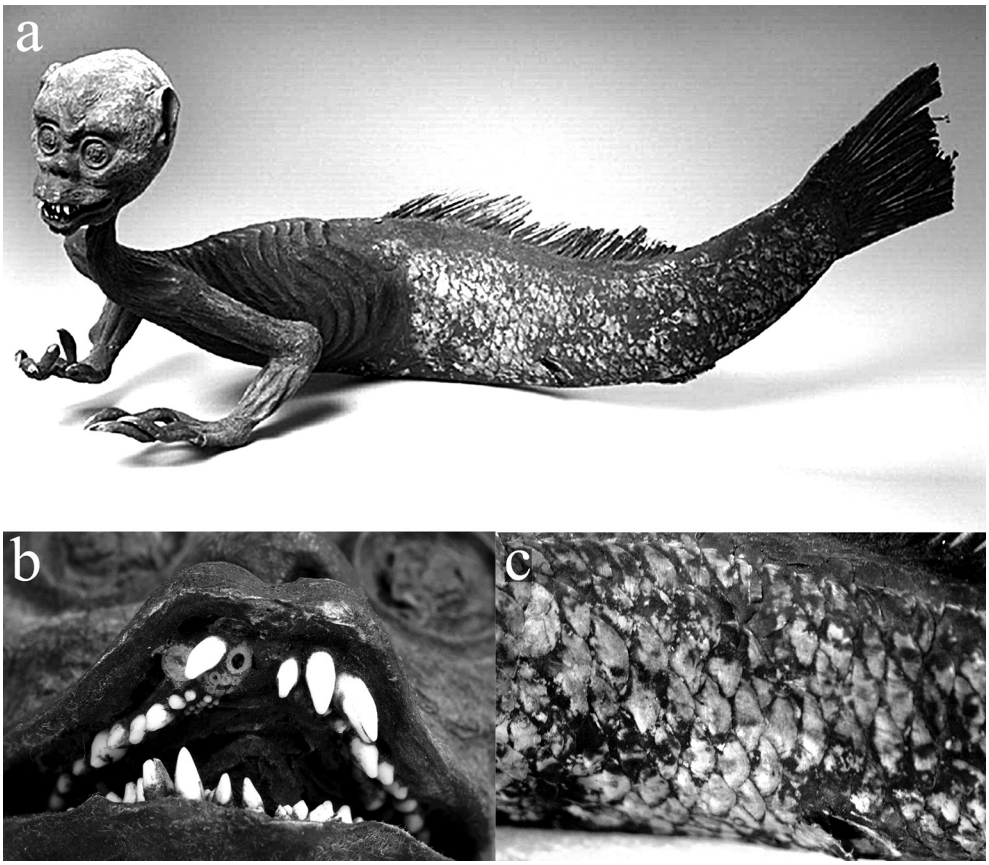

Figure 2. The 'Japanese Monkey-fish' in the collections of the Horniman Museum (NH.82.5.223): (a) complete figure, (b) close-up of mouth, (c) close-up of skin. From photographs taken for the museum by Paolo Viscardi in July 2010. Courtesy and copyright, Horniman Museum & Gardens.

that were kindly conducted free of charge at the Saad Centre for Radiography, City University, London.

CT Analysis

CT technology is usually employed in medical imaging and utilizes serial X-ray sections of the body in a single plane, which can then be manipulated by digital means to provide reconstructed sections in other planes. Individual volumetric pixels (voxels) indicate the density of materials being scanned at that point and are represented in greyscale, with the densest materials—such as metals—appearing white. Software can be used to manipulate CT data,

segmenting elements by their density and generating reconstructions of three-dimensional volumes. Using these techniques it is possible to separate dense bone from other tissues and to reconstruct isolated skeletal elements in 3D that can be rotated and examined in detail. In our analysis we used the software Mimics (Materialise, Leuven, Belgium) to perform these tasks, allowing us to obtain deeper insights into the construction of the Horniman merman.[5]

Because many elements of the specimen have similar or overlapping densities, it was not possible to automatically segment the CT data into component parts, as would be possible with flesh and bone. Fortunately, interpretation of the CT data was greatly assisted by reference to X-rays. It was clear from the X-rays that elements of metal (wire and a nail), wood (the internal structure of the body, shoulders, and tail), cord (the inner part of the head), a homogeneous material that may be clay, and less dense layers that appear to be cloth were used in the construction of the merman (Figures 3a–b). The X-ray images were used to help identify and delineate individual layers in three dimensions. For example, the density of the outer papier-mâché layer is very similar to that of the clay layer, although the materials are clearly separate and differ in homogeneity (Figures 3c–g). By looking through sections of the CT data where these layers interface, it was possible to determine how to separate them manually. Once other densities had been segmented from the data, a three-dimensional volume of the clay and papier-mâché layers was prepared and the outer layer was 'digitally dissected' (by rotating the three-dimensional image on the screen and labelling regions for deletion) leaving only the inner clay. This technique was used to fully separate each layer of material in the specimen. The result was a digital model of the merman in which each element of construction could be visualized in isolation, or together with other materials (Figures 3h–k). Although this analysis revealed few novel gross structural findings that were not apparent from the X-ray images, it provided a unique insight into the likely method of construction, as each layer could be added in sequence. Additionally, slight differences in the densities of small pieces allowed for the closer inspection of how individual parts were held together with pegs and such like.

Construction

The construction of the merman appears to have begun with two sections of wood nailed perpendicularly to form a torso and shoulders. A notch cut vertically into the front of the torso accommodates the neck piece, the coarser grain of which suggests the use of a different kind of wood. Two pegs, possibly of bamboo, inserted through the arms of the torso notch hold the neck in place. A horizontal groove cut into the rear section of the torso provides a bed for the wire spine, which runs in a single curving piece to the tail. Metal objects (such as metal dental fillings) create a flare in CT images, producing artefacts

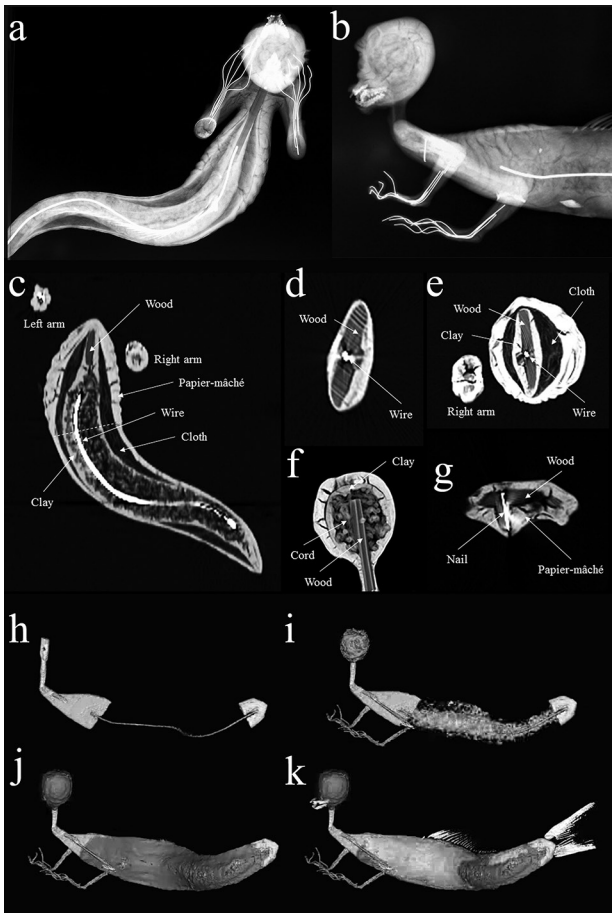

Figure 3. CT and X-ray images of the 'Japanese Monkey-fish' in the collections of the Horniman Museum (NH.82.5.223): (a–b) dorsal and lateral X-rays; (c) longitudinal section illustrating the different layers, materials used, and the limited variation in densities (the dashed line demarcates the fish section from the artificial front portion; (d) illustrating the fine wood grain of the tail-piece and effects of flare from the dense wire; (e) cross-section of the head and neck (coarser grain of the wood in the neck indicates a different wood from other parts of the specimen; the outer part of the head is made of papier-mâché; (f) cross-section through the torso, showing the wire spine, wooden body-form covered in clay, cloth, and the papier-mâché outer layer; (g) detail of the shoulder crosspiece, showing a nail holding sections of wood together (the nail generates significant flare artefacts); (h–k) the stages in the construction reproduced using rendered CT data. From images taken for the museum by the Saad Centre for Radiography in July 2010 and Tony Riber in October 2005. Courtesy and copyright, Horniman Museum & Gardens and James Moffatt.

(Figures 3d, 3g) that require manual removal. Without the X-ray images, the single nail securing the shoulder crosspiece may have been disregarded as an aberration of the scanning process, as it appears on only two or three sections of the data.

The groove in the torso accommodating the wire is wider than the wire itself and there is a small piece of wood of similar grain density to that of the neck adhered over the groove. A layer of cloth (possibly fixed with glue) is wrapped around the rearmost part of the wooden torso form and is subsequently more thickly wound around the wire up to the tail piece. An arrow-shaped piece of wood is attached at the tail end of the wire (Figures 3d, 3h, 3i), presumably to prevent the wire piercing the fish skin and to provide a form for the end of the tail. The thickness and grain of the wood of the torso and tail pieces were similar, suggesting that they had the same source. Over the top of the cloth a layer of homogeneous material that we interpret to be clay had been applied smoothly. A hole in the top of the neck provided an attachment point for a length of cord, which was wound around to bulk up the head, inadvertently producing a brain-like structure on X-ray and CT images (Figures 3b, 3e). The upper arms, one formed from a piece of wood, the other possibly from rolled paper, were probably added at this point. The inner structure of the forearms and hands was provided by bent wire. Final construction involved additional layers of cloth to fill the space between the body form and the skin of the fish.

The tail seems likely to have been made from the body of a carp with the head removed at the gill slits and the body cut along the belly, allowing removal of the internal organs and muscle. The inside of the skin was likely washed and treated with a preservative (possibly salt) before being stretched over the prepared form, with cloth added as padding, since the clay layer does not closely correspond to the skin in several places. The cloth layer continues up the torso to provide bulk to match the dimensions of the tail. The outer papier-mâché layer had been applied over this, with wrasse jaws embedded to make the mouth, and the rest of the head and torso had been sculptured to create features and the impression of bones and sinews. The junction between the torso and tail and the seam along the underside of the tail had been coated with a tinted resin or gum to disguise the joins.

Buxton Mermaid

The Buxton mermaid was chosen as the subject of a research and conservation project undertaken by Hollinshead at the University of Lincoln between autumn 2010 and spring 2012. The mermaid had been on display since 1988 as part of a discrete 'Cabinet of Curiosities' exhibition, but the information provided about the specimen was minimal, a situation the project sought to address in order to inform its future care and interpretation.

Serendipitously, Hollinshead contacted the Horniman Museum while the research into its merman was underway and visited the Horniman to see the results of the analyses outlined above. The research on the Horniman specimen was largely complete at this point and the 'Object in Focus' loans project was being planned, with the merman selected for a series of six loans. It was agreed to end the tour with a reunion between the merman and the mermaid at Buxton Museum in March 2012. To inform the necessary conservation of the mermaid, information was required about its construction and composition.

The Buxton mermaid stands in an upright position, balanced on the curve of the tail with the right arm folded across the chest and the left arm raised so that the hand is behind the head (Figure 4). From the position of the hands it seems possible that they were originally holding a comb and a mirror. The dimensions of the specimen are 38.0 cm x 18.0 cm x 12.5 cm, and on external examination it appeared to have been made from a combination of taxidermy (including a real fishtail), papier-mâché, and hair. The mermaid has modelled details such as ribs, fingernails, nipples, and a belly button. It also has eye-sockets, eyes, a nasal septum, teeth, and a tongue. A lot of work and imagination has gone into creating an object that might appear to be an anatomically accurate mummified mermaid.

Unfortunately, the years had not been kind to the specimen. The surface of the mermaid was very dirty and dusty, with the front much dirtier than the back. It seems likely that at some point the specimen had been displayed against a wall in a room with an open fire, smoke and soot migrating into the surface coating, causing discolouration. The surface coating was also very dry and fragile, with small flakes very loosely attached to the substrate and large flakes coming away with edges that were in danger of breaking. The hair came out at the lightest touch. The teeth were discoloured and stained, and a large flake of pigment was missing from the left eye. The fins on the tail were dry, fragile, broken, and bent out of shape in places. A piece of the end of the tail was missing and there was a hole in the fish skin below the tail-fin. However, apart from the damage to the tail, the mermaid appeared to be structurally sound.

Conservation

The conservation of the Buxton mermaid was undertaken at the University of Lincoln. Forensic photographer David Padley took a comprehensive set of images of the mermaid that captured much more detail than could be seen by the naked eye. Forensic anthropologist Gillian Fowler confirmed that there was no human skeletal material present. Mike Shaw, a student working on fish DNA, took samples from the tail for analysis, but (as with the Horniman samples) the DNA had degraded beyond the point at which it could be analysed. Nicola Crewe examined hair samples using a scanning electron microscope and a

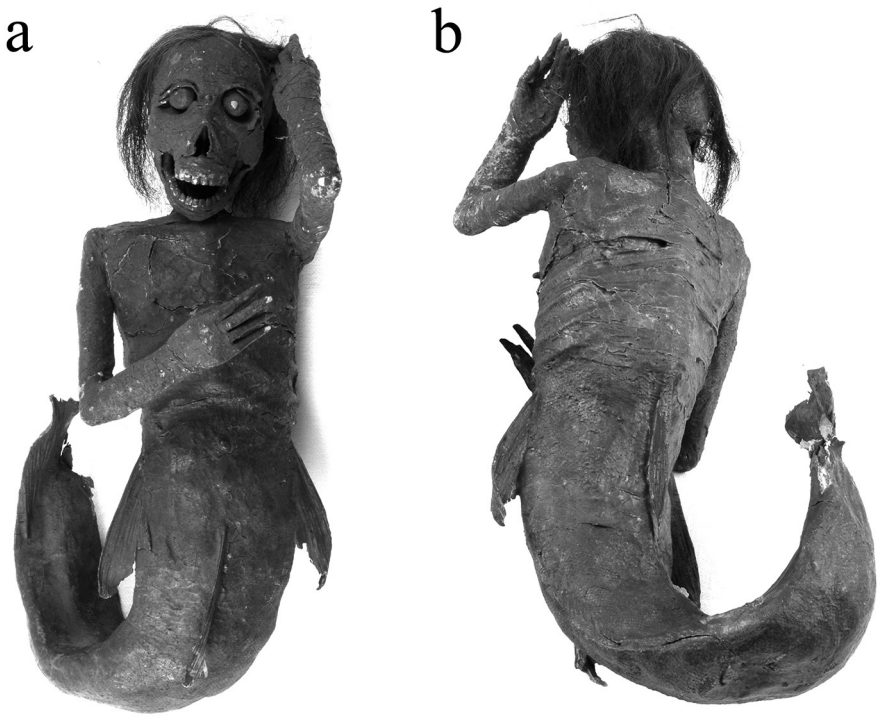

Figure 4. Front and back view of the mermaid in the collections of Buxton Museum & Gallery (DMS: A331) before conservation treatment. From photographs taken by David Padley in December 2011. Courtesy and copyright, David Padley.

transmitted light microscope, and was able to reach the following conclusions: the hair was almost certainly human and from a single donor, it was light to medium brown, in very good condition, had not been subjected to dyes or chemical treatments, and it was coated with a sticky debris composed of dirt, dust, and the surface coating of the specimen.

The mermaid was X-rayed using a Faxitron 43804N cabinet on a phosphor plate (Agfa CR MD4 OT) and subjected to 20 kilovolts for two minutes.[6] The resulting high-quality images demonstrated very clearly the construction of the mermaid. The front-on X-ray (Figure 5a) revealed that the torso of the mermaid was created using an armature of wood and wire with a stuffing of fibrous material. The shoulders and spine are built from wood held together with hand-made nails,[7] and the ribs are created from what is likely to be hand-drawn, extruded wire. The grain of the wood is visible and is also seen along the left arm, which may mean that the fingers are made of carved wood. The fingernails are of a denser material and may be slithers of bone, or possibly mother-of-pearl. The teeth are of a different density to other materials in the head and are interpreted as carved bone. There is no other bone present in the

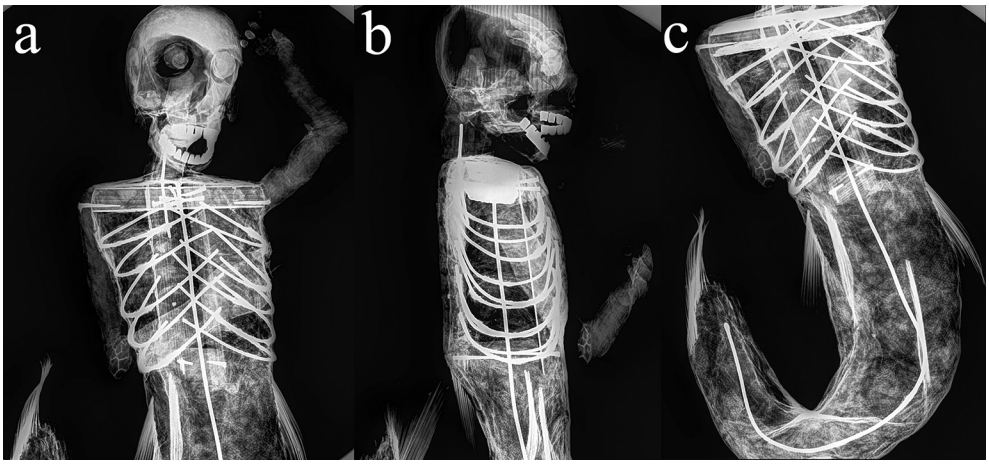

Figure 5. X-ray images of the mermaid in the collections of Buxton Museum & Gallery (DMS:A331): (a) from the front; (b) side view from right to left; (c) the tail from front to back. From images taken by Jo Wright in January 2012. Courtesy and copyright, Jo Wright.

head, despite the appearance of a structural 'skull'. It is not clear from Figure 5a how this skull was made, although Figure 5b shows wood grain in the side view of the skull. This is not visible in the first X-ray because it is in a plane parallel to the grain. The head is attached to the shoulders by wire and a wooden 'neck' that starts at the shoulders and goes up inside the skull.

A lot of effort went into creating the head: the skull has a cavity at the back where the wood has been hollowed out, creating a bowl-like structure. The nose is a separate slither of wood with a distinct septum. The eyes are made of an unknown material that has a higher density than wood. The torso appears to have been modelled on a human chest with wooden shoulders and a wooden spine. The wire ribs are attached to this spine and overlap at the front. Figure 5c shows the single wire running from the shoulders to the tip of the tail, creating a curved shape. It appears that all four fins at the top of the tail were reattached after the tail was stuffed, since no fish has four fins in this arrangement. The tail-fin is original. The fish skin was stuffed with what appears to be textile or paper, visible through the end of the tail and on the X-ray. The fish skin was cut and folded into shape at the top of where the tail curves.

The surface of the torso was examined closely with fibre-optic cold lights, hand lens, and microscope, which revealed a layer of material with a caramel-like appearance. There was an air bubble in this material that, through the microscope, revealed that the armature had been wrapped in a loosely woven white fabric (linen, silk, or cotton) creating the appearance of fish skin. Using the Biuret test, a fragment of the coating tested positive for the presence of protein, indicating that it was some form of animal-derived glue. This precluded the use of water-based cleaning methods, as they would dissolve the coating.

The mermaid was lightly cleaned using a smoke sponge after the method proved safe and effective when used on a small test area. Soft brushes and a vacuum (on a very low setting) were used to clean around the eye sockets. A fine paintbrush was used to try to lightly remove dirt from the hair, but this caused hairs to become detached and the process was stopped immediately and a loose silk net 'bonnet' was made to protect the hair from any further damage during cleaning.

The surface of the mermaid was extremely fragile, so once cleaned it required consolidation. The approach adopted was to apply a consolidant under the surface of the small loose flakes with a fine paintbrush. Other larger flakes of the surface had come away from the substrate, making their edges vulnerable to snapping off, so a decision was made to fill behind these flakes with a Japanese tissue pulp—a standard conservation technique rather than an object-specific decision—to provide support and stabilization. Before attempting this technique, tests were undertaken by replicating the surface coating of the mermaid by partially gluing samples of parchment on to a wooden substrate with wood glue so that there were gaps at the edges. These recreated the gaps around the edges of the large flakes of surface coating that had become detached from the substrate on the specimen.

The test gaps were filled with two different paper pastes; the first made from Japanese tissue pulped in a solution of Evacon-R™ (15% in distilled water), and the other made from carboxymethyl cellulose (20% in distilled water). The carboxymethyl cellulose did not adhere effectively to the substrate or parchment; the Evacon-R™ was effective but set too hard in the first test, so was used at 10% instead.

To consolidate the flaking surface on the arms, hands, face, shoulders, and some parts of the torso, a 10% solution of Klucel G (hydroxypropyl cellulose) in distilled water was applied on the tip of a fine paintbrush so that it was drawn under loose surface flakes. Klucel G was selected after discussions with Kim Sloan at the British Museum, where Japanese tissue and Klucel G was used to repair an eighteenth-century Japanese merman in 2002. This technique worked well on the Buxton mermaid and the surface was much more stable afterwards. The larger flakes on the surface of the mermaid were stabilized with the Japanese tissue and Evacon-R™ pulp tinted with acrylic pigment so that it blended into the colour of the original substrate.

The misshapen fins were rehydrated using a preservation pencil, set to 55°C, which passed a stream of water vapour through a nozzle into the fins. The rehydrated fins were gently bent back into shape and clamped between pieces of acid-free board until dry. Very fine Japanese tissue and Klucel G (10% in water) were used to back up and support the damaged areas of the rehydrated fins and to repair the damage at the end of the tail. Japanese tissue paper used to repair the fins and tail was also colour matched with acrylic pigments. Finally, the specimen was frozen to eliminate any insect pests. On 19 March 2012

the mermaid was returned to Buxton Museum to be exhibited alongside the Horniman merman for two months.

Discussion

Interdisciplinary collaboration has played a key role in contextualizing and understanding the results of our research, providing the information needed to formulate a working hypothesis for exploring the history of mermaid figures as ethnographic objects. It is hoped that further work to test these hypotheses will be conducted to allow them to be treated as artefacts with historical Japanese cultural significance, rather than merely being considered hoaxes constructed with the primary intent of deceiving unwary Europeans.

New technologies have contributed significantly to understanding the construction of mermaid figures, and our findings contradict historical interpretations of the objects as being taxidermy chimeras constructed using mummified monkeys and fish. Such a taxidermy construction method was originally proposed by early-nineteenth-century European scientists in an effort to discount suggestions that specimens represented genuine mermaids (see Ritvo 1997). However, this interpretation requires that taxidermy was being practised in Japan at the time, an idea for which we have found no support; moreover, the 'monkey' components referenced by early anatomical commentators such as William Clift (see Bondeson 1999) included species that are not native to Japan and which were unlikely to have been available due to the *sakoku* policy. Instead, our collaborative imaging and archival research leads us to suggest that mermaid figures were constructed from by-products of food preparation (fish-teeth and skin) and other commonly available materials, using modelling techniques that were well established in Edo-period Japan.

Our research also leads us to consider that there may be two distinct types of mermaid figure from Japan: a traditional pre-1850 form, with a strongly curved tail and hands raised to the face; and a post-1850 form (as represented by the Horniman specimen) made for export to meet demand from European and American museums and private collectors. Where the Buxton mermaid fits into this working hypothesis is as yet uncertain. The specimen may have been produced in Japan during the transition from traditional form to export form, or it may have been made somewhere other than Japan; possibly in Africa, and perhaps in Sierra Leone, since that is where the last-known owner, Mr Graham, was based. Indeed, the Buxton mermaid may be a representation of one of the many female African water spirits that have recently been subsumed as precursors of Mami Wata and which were often represented with comb and mirror (see Drewal (ed.) 2008). The similarities of the specimen to the 'scream' type *ningyo* (in particular the strongly curved tail) may possibly have been inspired by representations of mermaids seen in Africa *en route* to

Europe. There are, for instance, accounts of such displays in Cape Town (see Anonymous 1822). Alternatively, it may be that Japanese specimens found their way to the Dutch Gold Coast on Dutch ships and were subsequently acquired by Mr Graham, who is known to have been collecting ticks in the Gold Coast area in October 1906 (see Keirans 1985: 98). It is interesting to note that Mr Graham had at least one other mermaid that was posed in a similar manner (see Anonymous 1921), and it may be that he constructed them himself as an exercise in anatomy. This suggestion is supported by the remarkable similarities between the internal structure of the Buxton specimen and the skeletal arrangement of a human, as revealed by the phosphor plate X-rays. Further research is required to address properly this possibility.

Finally, it is worth mentioning the value of new technologies in displaying information about the Horniman merman. Public interest in the construction of the specimen partly drove the initial research into the merman, so it was appropriate to display results of the analysis undertaken to address that interest. Initially, the raw output images of the CT scans were converted into a video file and played through a digital photo-frame next to the specimen, with a text-panel interpreting these results. The technique was not very engaging, and the digital photo-frame was unsuited to long periods of constant use. To improve the experience for visitors a series of videos of rotating, rendered 3D models of the specimen at various stages of construction were produced and displayed, with additional images and interpretation text on a touch-screen unit. This allowed visitors to explore both the specimen and the research in more detail, creating a far more engaging interactive experience. The videos produced were also suitable for dissemination more widely through social media, blogs, and online news reports.

A considerable body of historical information has been collected about these and other mermaid specimens during the course of this research, which there is insufficient space to explore in more detail in this paper. However, preparations are underway for a comprehensive exhibition on mermaids from UK collections, so we hope that more opportunities for sharing the findings of our research will present themselves.

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Notes

1. For more information on the Horniman's 'Objects in Focus' project, go to <http://www.horniman.ac.uk/about/object-in-focus-loans>.
2. For more on this, see the page on the Wellcome Library's website entitled 'Researching Objects from the Wellcome Historical Medical Museum', at <http://wellcomelibrary.org/about-us/history-of-wellcome-library/wellcome-historical-medical-museum/>.
3. This story of prophylaxis provides a possible justification for the inclusion of the mermaid figures in Wellcome's collections, as does the Japanese folk story of Yao Bikuni, in which a young girl becomes immortal by unwittingly eating the flesh of a mermaid (see Glassman 2008: 182).
4. We are grateful to Oliver Crimmen of the Natural History Museum for this suggested identification.
5. For information on Mimics software, visit <http://biomedical.materialise.com/mimics>.
6. Exposure time was determined by tests conducted by Jo Wright using a taxidermy squirrel.
7. These were identified as hand-made on the basis of the shape of the nail-head.

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